Extent of Climate Risk Disclosure and Greenwashing: Evidence from IDX ESG Leaders Firms

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Abstract
Purpose: This study aims to examine examines the association between the extent of Climate Risk Disclosure (CRD) and greenwashing, and whether Board Gender Diversity (BGD) moderates this association, among companies listed in the IDX ESG Leaders index on the Indonesia Stock Exchange during 2022–2023.
Methodology/approach: A quantitative approach is employed using secondary data obtained from annual reports and sustainability reports. CRD is measured by an index of 11 binary items derived from the Task Force on Climate-related Financial Disclosures (TCFD) recommendations, which captures the extent rather than the quality of disclosure. Greenwashing is measured by the gap between environmental disclosure and environmental performance across 15 GRI-based items. BGD is the proportion of female directors, with profitability, leverage, and firm size as control variables. The hypotheses are tested using pooled ordinary least squares (OLS) with a year dummy and heteroskedasticity-robust standard errors, including moderated regression analysis (MRA), on 38 firm-year observations.
Results/findings: CRD has a positive but statistically insignificant association with greenwashing ($\beta = 0.1772$; $p = 0.210$), and the CRD × BGD interaction is negative but statistically insignificant ($\beta = -1.1954$; $p = 0.467$). Neither coefficient is significant at the 5% or the 10% level; therefore, H1 and H2 are not supported.
Limitations: The sample is small (N = 38) and the observation window is short, which limits statistical power and generalizability. The pooled specification does not control for unobserved firm-level heterogeneity, and the findings should be read as tentative associations rather than causal effects.
Contribution: This study contributes to sustainability accounting and corporate governance research by showing that the extent of climate risk disclosure alone does not discriminate between substantive accountability and symbolic disclosure, which qualifies the transparency-based reading of legitimacy theory. The moderating role of board gender diversity is examined on an exploratory basis. The findings suggest that investors and regulators should assess the consistency between disclosure and measurable performance in addition to disclosure completeness.

Keywords: *Climate Risk Disclosure, Greenwashing, Board Gender Diversity, Moderated Regression Analysis, IDX ESG Leaders*

1. Introduction

Climate change has heightened investor's and stakeholder's demand for corporate information on environmental risks and their implications for business sustainability. From an accounting perspective, Climate Risk Disclosure (CRD) forms part of reporting transparency, helping users of financial reports understand how climate risks affect a firm's strategy, operations, and financial condition. The Task Force on Climate-related Financial Disclosures (TCFD, 2017) organizes such disclosure into four pillars: governance, strategy, risk management, and metrics and targets. However, a large volume of disclosure does not necessarily reflect actual environmental performance.

This issue relates to greenwashing, namely the practice of presenting environmental claims that appear better than a firm's actual performance. Accounting assessments should not only consider the completeness of disclosure but also examine whether it is consistent with measurable performance. Environmental disclosure that is not backed by real performance can mislead information users when they evaluate a firm's accountability and sustainability. Therefore, researchers need to empirically test the relationship between Climate Risk Disclosure and greenwashing to determine whether climate risk transparency produces more credible environmental reporting.

Prior studies provide partial and inconsistent evidence on this question. Battisti et al. (2025) report that CRD is associated with lower greenwashing among Chinese A-share firms and that gender quotas moderate this relationship nonlinearly, using a large sample of 9,705 observations over 2016–2022. Mateo-Márquez et al. (2022) document that a growing volume of positive environmental information raises public skepticism about its authenticity, and Zahid et al. (2025) show that women on boards are associated with environmental performance, environmental disclosure, and greenwashing behavior. These studies are drawn from other institutional settings; the unresolved issue is whether the same patterns hold in an emerging market with a two-tier board system, where firms in an ESG-labelled index face heightened investor scrutiny that may induce either substantive accountability or symbolic disclosure. Indonesian ESG-index firms are therefore a theoretically informative setting for testing whether disclosure extent narrows the gap between disclosure and performance.

This study applies Legitimacy Theory, which holds that firms seek to maintain societal acceptance by aligning their activities with social expectations. Under this theory, firms may use Climate Risk Disclosure as substantive accountability to society. Firms may also use it to build a positive image when its content is inconsistent with their actual performance. The study positions Board Gender Diversity (BGD) as a moderating variable because board composition influences oversight and decision-making on environmental responsibility. Zahid et al. (2025) find that board gender diversity is associated with environmental performance, environmental disclosure, and greenwashing behavior, so these findings warrant further testing in the Indonesian context.

The study focuses on firms listed in the IDX ESG Leaders index on the Indonesia Stock Exchange during 2022–2023. Investors pursuing ESG-based strategies pay attention to these firms, so the credibility of their environmental disclosure merits examination. The study includes profitability, leverage, and firm size as control variables so that differences in financial condition and operational scale do not bias the results. Accordingly, association between the extent of Climate Risk Disclosure and greenwashing and tests the moderating role of Board Gender Diversity in that relationship.

The incremental contribution of this study is limited and contextual rather than methodological. It jointly examines (i) a TCFD-based index of disclosure extent, (ii) a performance-disclosure gap measure of greenwashing, and (iii) board gender diversity within one empirical framework for Indonesian ESG-index firms. The study does not claim methodological novelty, and its small sample warrants an exploratory interpretation of the results

2. Literature Review and Hypothesis Development

2.1. The Impact of Climate Risk Disclosure on Greenwashing

Climate Risk Disclosure (CRD) is a firm's disclosure of the climate risks and sustainability-related environmental impacts it faces, made as an act of accountability to investors, regulators, stakeholders, and the public. This responsibility reflects the firm's commitment to a long-term sustainable economy, the firm focuses not only on profit but also on the environmental impact of its operating activities. By disclosing climate risk, firms seek to build relationships and increase public trust, so that their operations receive public support.

The relationship between Climate Risk Disclosure and greenwashing is complex and contradictory. High-quality Climate Risk Disclosure is expected to improve a firm's transparency and accountability regarding climate risks, thereby reducing the likelihood of greenwashing. A firm that discloses climate

risks in a substantive and verifiable manner will find it difficult to make sustainability claims that lack adequate evidence, because such disclosure is subject to closer scrutiny from investors, regulators, and the public (Battisti, Bo, et al., 2025). Existing evidence on the direction of the relationship between CRD and greenwashing remains highly mixed. Therefore, this study draws on Legitimacy Theory as its theoretical foundation to explain the negative relationship between Climate Risk Disclosure and greenwashing.

According to Legitimacy Theory, firms seek to obtain and maintain public legitimacy by ensuring that their activities are consistent with the values, norms, and expectations prevailing in their social environment. As firms face growing public attention and demands regarding environmental issues and climate change, they need to demonstrate that their business activities take into account the impacts and risks arising from climate change. One form of corporate response to these demands

Legitimacy theory supports two competing mechanisms. Under the substantive mechanism, disclosure is a vehicle of accountability: when a firm reports its governance of climate risk, its risk-management processes, and its metrics and targets, it exposes itself to verification by investors and regulators, which narrows the room for claims unsupported by performance. Under the symbolic mechanism, disclosure is an image-building instrument: firms under strong legitimacy pressure may expand disclosure to appear compliant without improving actual performance, so the gap between disclosure and performance persists or widens (Mateo-Márquez et al., 2022; Battisti et al., 2025). The substantive mechanism is expected to dominate when disclosure is scrutinized and substantiated by quantitative information, whereas the symbolic mechanism is expected to dominate when legitimacy pressure is not matched by performance capability. IDX ESG Leaders firms are visible to ESG-oriented investors, and the CRD index used here includes metrics-and-targets items that are comparatively verifiable. Because scrutiny and verifiability are both high in this setting, this study expects the substantive mechanism to prevail and therefore predicts a negative association between CRD and greenwashing. The symbolic mechanism is retained as the alternative explanation for a null or positive result.

In an accounting context, climate risk disclosure is part of corporate information disclosure that provides information on climate change risks and opportunities, as well as their potential and impact on a firm's operations, financial condition, and going-concern sustainability. Such disclosure enables information users to gain a better understanding of how a firm performs in managing climate change risks. As a result, climate risk disclosure serves not only as environmental information but also carries economic relevance in supporting the decision-making of users of corporate reports.

H1. *CRD has negative impact on greenwashing*

2.2 The Moderating Effect of Board Gender DiversityBoard

Gender Diversity is the proportion of women on a firm's board of directors relative to total board of directors membership, and it reflects the degree of gender diversity in the organization's top leadership structure (Carter et al., 2003). In the context of the two-tier board system applied in Indonesia, gender diversity may be observed in two layers: the board of directors, which is responsible for managing the company, and the board of commissioners, which is responsible for the oversight function (Ratnawati, 2019).This study operationalizes BGD only at the board of directors, because directors prepare and are accountable for the content of corporate disclosure; the board of commissioners is left for future research.Board gender diversity may influence greenwashing in two possible directions. First, a gender-diverse board can strengthen corporate governance and thereby reduce the risk of greenwashing (Ma & Ahmad, 2024). Second, firms that adopt gender quotas merely to meet regulatory demands, rather than out of genuine commitment to diversity, may treat the policy as a symbolic gesture, which can increase greenwashing. This view is consistent with the concept of weak sustainability, which holds that firms often undertake sustainability measures to enhance their legitimacy rather than to achieve substantive environmental improvement (Demastus & Landrum, 2024).Legitimacy theory posits that a firm's survival and long-term success depend on its ability to meet societal expectations through appropriate

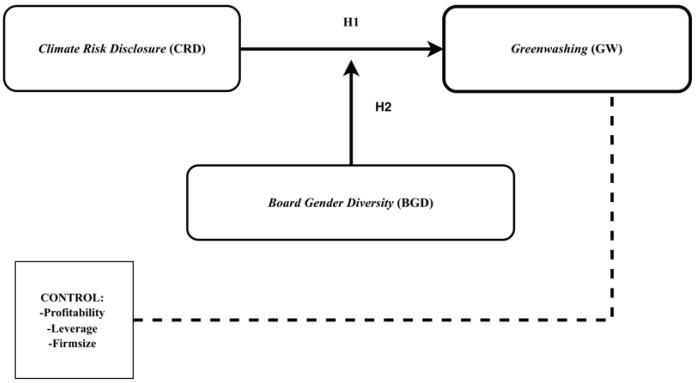
institutional arrangements (Velte, 2022). In response to such external legitimacy pressures, firms of different sizes may adopt different governance mechanisms. Prior studies show that firms typically benefit from more formal governance structures (Rizwan & Chughtai, 2023), larger boards (Fedaseyeu & Lvovskiy, 2025), and better access to resources (Tian et al., 2024). Firms that can more easily meet these three conditions tend to gain a tangible governance contribution from gender diversity initiatives. Large firms are also generally better positioned to integrate gender quotas (GQ) into their ESG strategies.

Upper Echelons Theory explains that the presence of women on the board of directors brings ethical values, fresh perspectives, and a more cautious leadership style. When these expectations are met, firms succeed in aligning their governance values with social norms, consistent with legitimacy theory, which emphasizes the importance of maintaining the social contract with the public (Suchman, 1995). Through this lens, gender diversity on the board of directors is used as a strategic instrument to respond to external pressure while securing economic support and social recognition over the long term. Accordingly, gender diversity on the board of directors is not merely a matter of formal compliance but a strategic response by firms to protect their reputation and business sustainability.

Research links women directors to stronger governance outcomes. Women directors are associated with tighter oversight (Adams & Ferreira, 2009), greater attention to stakeholder interests and environmental responsibility (Post et al., 2011; Bear et al., 2010), and higher-quality sustainability reporting in emerging markets (Sundarasen et al., 2024). Industry research also links executive gender diversity to superior performance outcomes (Dixon-Fyle et al., 2020).

H2. *BGD has a moderating effect on the relationship between CRD and greenwashing.*

2.3 Conceptual Framework



3. Methodology

3.1 data sample

This study can be categorized as quantitative research. Quantitative research aims to test hypotheses on the relationships between two or more variables. This approach is consistent with the objective of the study, which is to obtain empirical evidence on the effects of Climate Risk Disclosure, greenwashing, and Board Gender Diversity among firms listed in the IDX ESG Leaders index. The study uses secondary data obtained from the annual reports and sustainability reports of firms available on the Indonesia Stock Exchange (IDX), which serves as the primary source of information. The secondary data are retrieved from the idx.co.id website in the form of corporate financial reports and sustainability reports of firms listed in the IDX ESG Leaders index.

The sampling procedure follows three rules. First, a firm is eligible in a given year if it is a constituent of the IDX ESG Leaders index in that year. Second, a firm-year is retained only if both the annual report and the sustainability report are available for content analysis. Third, a firm-year is excluded if the data

needed to compute the greenwashing score or the control variables are missing. Table 1 summarizes the selection process.

Table 1. Sample Selection

Selection Criteria	2022	2023
Firm-years of IDX ESG Leaders constituents (eligible)	40	40
Less: annual/sustainability report not available for coding	(0)	(0)
Less: missing data for greenwashing score or control variables	(2)	(2)
Final Sample (firm-year observations)	38	

3.2 Variables and estimation methods

First, CRD currently lacks a definitive measure, and most earlier studies rely on text analysis that counts word frequencies (Wang et al., 2024). In constructing the CRD indicator, we built the CRD measure through content analysis, which we used to assign weights to the climate-related indicators in the Task Force on Climate-related Financial Disclosures (TCFD) framework. We applied the same content-analysis approach to the greenwashing measure, using environmental performance indicators drawn from the GRI index.

3.2.1 variable measurement

We constructed the CRD indicator using content analysis of the annual reports and sustainability reports of the sample firms, with the four pillars of the TCFD framework serving as the coding scheme governance, strategy, risk management, and metrics and targets. Under governance, we coded disclosures on board oversight of climate-related risks and opportunities and on management's role in assessing and managing them. Under strategy, we coded disclosures on the climate-related risks and opportunities the firm has identified, their effects on its business and financial planning, and the resilience of its strategy under different climate scenarios. Under risk management, we coded disclosures on the processes used to identify, assess, and manage climate-related risks and on how these processes are integrated into overall risk management. Under metrics and targets, we coded disclosures on the metrics used to assess climate-related risks, greenhouse gas emissions (Scope 1, 2, and 3), and the targets set and the firm's performance against them. Each disclosure item scored 1 if the report contained relevant information and 0 otherwise. The CRD score is the sum of item scores divided by the total number of items (11), so higher values indicate more comprehensive climate risk disclosure.

$$CRD = \frac{\text{item disclosure total}}{\text{11 item TCFD}}$$

The greenwashing construct is measured following Zhang et al. (2023), as the gap between disclosed environmental performance and actual environmental performance. This gap is derived through content analysis based on the GRI Standards: GRI 301 (Materials), GRI 302 (Energy), GRI 303 (Water and Effluents), GRI 304 (Biodiversity), GRI 305 (Emissions), GRI 306 (Waste), GRI 307 (Environmental Compliance), and GRI 308 (Supplier Environmental Assessment), with a total of 15 items distributed across these topics. Board gender diversity refers to gender diversity within the board of directors' structure, measured by the proportion of female board members to the total number of board members (Adams & Ferreira, 2009).

3.2.2 regression model

The data analysis technique employed in this study utilizes Stata 17 statistical software to conduct quantitative analysis. Stata 17 was selected based on its capability to analyze panel data and estimate regression models efficiently and accurately. This study utilizes panel data, which combines cross-sectional data (multiple companies) and time-series data (the observation period). The panel data regression equation in this study is formulated to test hypothesis H1.

Model 1:

$$GW = \beta_0 + \beta_1 CRD + \beta_2 BGD + \beta_3 ROA + \beta_4 DER + \beta_5 FirmSize\ \epsilon$$

In this study, MRA was applied to examine the role of Board Gender Diversity as a moderating variable in the relationship between Climate Risk Disclosure and Greenwashing. The moderated regression model in this study was formulated to test hypothesis H2.

Model 2:

$$GW = \beta_0 + \beta_1 CRD + \beta_2 BGD + \beta_3\ (CRD*BGD) + \beta_4 ROA + \beta_5 DER + \beta_6\ FirmSize + \epsilon$$

4. Results and Discussion

4.1 Regression Results

The hypotheses were tested using ordinary least squares regression with heteroscedasticity-robust standard errors and a year dummy, based on 38 firm-year observations of IDX ESG Leaders companies for 2022–2023. Table 1 reports the estimation of Model 1, which examines the effect of Climate Risk Disclosure (CRD) on greenwashing (GW).

Table 1. Regression Results of Model 1 (Effect of CRD on Greenwashing)

Variable	Coefficient	Sig.
CRD	0.1772	0.210
Profitability (ROA)	-0.2056	0.199
Leverage (DER)	0.0297	0.340
Firm Size	0.0009	0.898
Year dummy (2023)	-0.0245	0.606
Constant	0.0835	0.679

Source: Data processed using Stata 17 (2026). N = 38; $R^2 = 0.1311$; $F(5, 32) = 0.82$; Prob > F = 0.5413.

Table 2 presents the Moderated Regression Analysis (MRA) of Model 2, which adds Board Gender Diversity (BGD) and its interaction with CRD.

Table 2. Moderated Regression Analysis Results of Model 2

Variable	Coefficient	Sig.
CRD	0.4889	0.298
BGD	0.8055	0.439
CRD × BGD	-1.1954	0.467
Profitability (ROA)	-0.2030	0.186
Leverage (DER)	0.0377	0.289
Firm Size	0.0026	0.687
Year dummy (2023)	-0.0276	0.579
Constant	-0.1915	0.585

Source: Data processed using Stata 17 (2026). N = 38; $R^2 = 0.1617$; $F(7, 30) = 0.66$; Prob > F = 0.7021.

The regression results reveal that Climate Risk Disclosure (CRD) has a positive but statistically insignificant relationship with greenwashing ($\beta = 0.1772$; $p = 0.210$), indicating that higher climate risk disclosure does not significantly explain variations in greenwashing among IDX ESG Leaders companies. In level terms, a 0.1 increase in the CRD score, equivalent to roughly one additional TCFD

item out of 11, is associated with a 0.018-unit higher greenwashing score; this estimate is imprecise and not distinguishable from zero. Regarding the moderating effect, the interaction between Board Gender Diversity (BGD) and CRD exhibits a negative but statistically insignificant coefficient (β = −1.1954; p = 0.467). The sign is consistent with the direction predicted in H2, but the estimate is imprecise, so the data do not provide evidence that BGD alters the CRD-greenwashing association. The direct BGD coefficient is positive and likewise insignificant (β = 0.8055; p = 0.439). Among the control variables, profitability shows a negative but insignificant relationship with greenwashing (β = −0.2030; p = 0.186), whereas leverage (β = 0.0377; p = 0.289) and firm size (β = 0.0026; p = 0.687) exhibit positive but statistically insignificant relationships. Overall, neither the direct relationship between CRD and greenwashing nor the moderating effect of BGD is statistically significant at the 5% or the 10% level.

Table 3. Summary of Hypothesis Testing

	Hypothesis	Result	Decision
H1	CRD has a negative impact on greenwashing	β = 0.1772; p = 0.210	Rejected
H2	BGD moderates the relationship between CRD and greenwashing	β = -1.1954; p = 0.467	Rejected

Source: Data processed using Stata 17 (2026).

4.2 Discussion

The insignificant effect of CRD on greenwashing is consistent with the mixed evidence in the literature. Battisti, et al. (2025) find that CRD reduces greenwashing among Chinese A-share firms, but their analysis covers 9,705 observations over 2016–2022. The present study relies on 38 observations over two years, which limits the statistical power to detect a small effect.

The positive sign of the CRD coefficient can be interpreted through Legitimacy Theory. Firms in the IDX ESG Leaders index face strong legitimacy pressure from investors and regulators. Under such pressure, climate risk disclosure may serve as a symbolic instrument to build a favorable image rather than as substantive accountability, so the gap between disclosure and performance does not narrow. Mateo-Márquez et al. (2022) similarly note that a growing volume of positive environmental information raises public skepticism about its authenticity. This explanation remains tentative because the coefficient is not statistically significant. The result also qualifies the transparency-based reading of legitimacy theory: a higher extent of disclosure, measured by the presence of TCFD items, does not by itself distinguish substantive accountability from symbolic disclosure. Distinguishing the two requires information on disclosure quality and verification, which the binary index cannot capture.

The finding on BGD reflects the inconsistent evidence on the role of women directors. Eliwa et al. (2023) report that board gender diversity reduces ESG decoupling, whereas Zhang et al. (2023) finds that female-managed firms are more likely to engage in greenwashing. The insignificant interaction suggests that the presence of women on boards in the sample has not changed how disclosure relates to greenwashing. Two results should be kept separate. The direct BGD coefficient (β = 0.8055; p = 0.439) does not indicate a significant difference in greenwashing between firms with higher and lower female representation. The interaction coefficient (β = −1.1954; p = 0.467) has the sign predicted by H2, but it is not statistically significant, so the data do not show that female directors change how disclosure relates to greenwashing; the negative sign is treated as indicative only, in line with the exploratory nature of the moderation test. This may stem from symbolic compliance consistent with the weak sustainability view (Demastus & Landrum, 2024), or from a female board proportion that is too small to influence environmental decision-making (Adams & Ferreira, 2009).

Beyond the small sample, other factors may contribute to the insignificant results. These include limited variation across firms, the binary 11-item coding of CRD, and potential multicollinearity among CRD, BGD, and their interaction, which should be examined through a Variance Inflation Factor (VIF) test.

5. Conclusion

This study examines the association between Climate Risk Disclosure and greenwashing and the moderating role of Board Gender Diversity among IDX ESG Leaders companies during 2022–2023. The results show that CRD is not significantly associated with greenwashing (β = 0.1772; p = 0.210), so H1 is not supported. BGD does not significantly moderate this relationship (β = -1.1954; p = 0.467), so H2 is not supported. Profitability, leverage, and firm size are also not significantly associated with greenwashing. These findings indicate that the extent of climate risk disclosure does not by itself coincide with the credibility of environmental reporting. Descriptively, investors and regulators may complement checks of disclosure completeness with checks of whether disclosed information matches measurable environmental performance. Because the evidence is an association in a short, small panel and is statistically weak, it does not support causal conclusions or recommendations for changes in board composition.

Limitations and Future Research

This study has several limitations. The sample is small (N = 38) and covers only two years, which restricts statistical power and the generalizability of the findings. The estimation also relies on pooled regression with a year dummy and does not exploit firm-level heterogeneity; firm-level dependence between repeated observations of the same firm is not modelled, and inference based on few firms should be treated with caution. The CRD index and the greenwashing score are based on binary content coding, which measures extent rather than quality or verification of disclosure. Future research should extend the observation period, broaden the sample to all listed firms publishing sustainability reports, apply panel estimation with fixed or random effects, and test nonlinear relationships between CRD and greenwashing as suggested by Battisti et al. (2025). Alternative measures of board diversity, such as the proportion of women in the board of commissioners and the board of directors separately, may also be considered. Future studies may also develop disclosure-quality measures, such as specificity and external assurance, to separate substantive from symbolic disclosure.

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Appendix A. Climate Risk Disclosure Checklist (11 TCFD iTEMS)

NO	TCFD Pillar	Disclosure item (scored 1 if disclosed, 0 otherwise)
1	Governance	Board oversight of climate-related risks and opportunities
2	Governance	Management's role in assessing and managing climate-related risks and opportunities
3	Strategy	Climate-related risks and opportunities identified over the short, medium, and long term
4	Strategy	Impact of climate-related risks and opportunities on business, strategy, and financial planning
5	Strategy	Resilience of the strategy under different climate-related scenarios
6	Risk management	Processes for identifying and assessing climate-related risks
7	Risk management	Processes for managing climate-related risks
8	Risk management	Integration of these processes into overall risk management
9	Metrics and targets	Metrics used to assess climate-related risks and opportunities
10	Metrics and targets	Greenhouse gas emissions (Scope 1, 2, and 3) and related risks
11	Metrics and targets	Targets used to manage climate-related risks and performance against targets

Source: TCFD (2017) recommended disclosures.

Appendix B. Greenwashing Item Based on GRI Standards

GRI Topic	Item
GRI 301 Materials	**2**
GRI 302 Energy	**2**
GRI 303 Water and Effluents	**2**
GRI 304 Biodiversity	**2**
GRI 305 Emissions	**2**
GRI 306 Waste	**2**
GRI 307 Environmental Compliance	**2**
GRI 308 Supplier Environmental Assessment	**1**
Total	**15**